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An Investigation on Utilization of Marble Dust and Rice Husk Ash as Replacement of Cement by Addition of Sisal Fibre

Sathanandham.T[1], Ajith Kumar.R[2], Gokul Raj.V[3], Pragathi.P[4*], Sathish Kumar.S[5]
[1]Assistant Professor, [2,3,4,5]UG Student
Department of Civil Engineering, Jai Shriram Engineering College, Tirupur, India.
Corresponding Author
E-Mail Id:-*pragathi29091998@gmail.com*

ABSTRACT

Marble waste is one of the most abundant waste materials produced every year. A total of 64trillion tonnes of quarry waste are produced every year. To minimize the waste produced from quarry its byproducts are being used in construction industries. As another major source of wastes, agro based industrial wastes are also utilized in building materials. Rice husk ash is a byproduct obtained after inceneration process and it is a cementitious material. In this investigation marble dust and rice husk ash are used as a replacement for cement. The marble dust is replaced in varying proportions such as 0%,10%,15%,20%,30% in a total replacement of 30% of cement, where in each proportions the remaining percentage is filled by Rice husk ash. Marble dust contains more than 50% of silica oxide in it. Hence the structure built with marble dust are stronger and more durable. Index property and engineering property of the admixtures and materials used were obtained in the laboratory. Along with these admixtures' sisal fibre with aspect ratio 100 is added as reinforcing agent. It is added in proportion of 0.1% and the additives were also included. The results of the test specimen on 7,14 and 28 days tests are noted down. The compressive strength of the concrete is obtained by using compressive testing machine (CTM), as well as rebound hammer. The test results for destructive and non destructive test results were compared with each other.

Keywords: *Marble dust, rice husk, cement, sisal fibre, compressive strength*

INTRODUCTION

In the modern scenario, no construction activity has been imagined without using concrete. Concrete is widely used building material in the construction industry. The main reason is its high strength and durability. The possible applications of industry by-products in concrete are as partially replacement of cement with Marble Dust Powder and Rice Husk Ash. The use of such materials in concrete reduces the environmental pollution. These investigations try to satisfy the social needs for safe and economic construction with waste materials, which needs enhanced and cost effective materials. A huge amount of the cement used in the construction work, the continuous increase in the price of Portland cement is attributed to the inadequate production rate of raw materials when compared with demand rate. The Ordinary Portland Cement (OPC) concrete is a brittle material. Micro cracks present in the concrete leads to brittle fraction of concrete. In plain concrete structural cracks can be developed before loading due to drying shrinkage and other causes. When load is applied the internal cracks propagate and additional cracks are formed. The development of this cracks cause of inelastic deformation in concrete. The addition of fibres in concrete can act as a crack arrester and improves its static and dynamic properties and also increases structural performance.

The fibre along with the waste materials is added in the concrete and the test specimens are casted. M20 design mix is used for the research. Cube specimen of size 150mm x 150mm x 150mm is casted and it is cured. The tests were done on 7days,14days and 28days by both destructive and non destructive method. The peak values for the optimum design mix is noted. Rice husk ash currently recognized as pozzolona. A pozzolona is a silicious / aluminous material which in itself has little or no cementious value, but which will in finely divided from and in the presence of moisture, chemically reacts with calcium hydroxide liberated during the hydration of Portland cement to produce stable , insoluble cementitious compound which contributes to its strength and impermeability **[1].** The marble powder used was obtained from the processing plants out of sawing and polishing of marble blocks. Marble powder is brought Egyptian factories of marble company. Rice husk ash is an agricultural waste product, and how to dispose of it is a problem to waste managers. While concrete today has assumed the position of the most widely used building globally. The ash collected was sieved through BS standard sieve size 0.075 mm and its colour was grey. RHA from the parboiling plants is posing serious environmental threat and way are being thought of to dispose them. The material actually a super pozzolona since it is rich in silica and has about 85% to 90% silica content**[2**].

SCOPE & OBJECTIVE OF THE PROJECT

- To use marble dust which is one of the industrial wastes in any other works to reduce the ecological problems.
- Also to increase the use of agricultural waste such as rice husk ash in the construction field to reduce the problems in disposal.
- To utilize the sisalana fibre as a reinforcing element in the concrete to increase the tensile strength of the concrete.
- To increase the mechanical property of the concrete by addition of waste materials as an admixture.
- To compare the compressive strength results between destructive and non destructive test methods.
- To achieve the higher strength in compression by adding the mineral admixture without modifying the properties of the concrete.
- To reduce the cost of construction by minimizing the use of cement and its raw material.

MATERIALS AND METHODS

In this research the admixtures used such as rice husk ash and marble dust are tested in the laboratory for its index properties. Specific gravity, finess modulus, and bulk density of both the materials are calculated. The aspect ratio for the reinforcing fibre is calculated with the help of a vernier calliper. The concrete is casted by mixing the mix with mixer machine and after the final setting time of concrete the mould is removed and the specimen is kept for curing. After 7,14 &28 days the immersed specimens were taken out and then dried and tested. For investigating the physical and chemical components of the concrete after curing, mineralogical studies are carried out. The compressive strength of the cube is found by both Rebound hammer and also Compressive testing machine. The various materials and admixtures used in the research are listed below and their properties are noted accordingly.

FINE AGGREGATE

M sand is used as the fine aggregate. M sand is also called as crusher sand which is obtained during the crushing and grinding of coarse aggregate. The fine aggregate

with a specific gravity of 2.5 is used. The fine aggregate used in the research is verified as per **IS 2386-1963** Indian standards. The sand used is sieved with 4.75mm to avoid any gravels.

Table 1: *Physical properties of fine aggregate*

Description	**Fine aggregate**
Specific gravity	2.5
Water absorption	1.64
Finess modulus	4.25
D_{60}	0.63
D_{10}	0.375
Co efficient of uniformity	2.5
Bulk density	1.833 g/cc

COARSE AGGREGATE

Crushed angular coarse aggregate of size Machine crushed angular granite metal of 20 mm nominal size from the local source was used as Coarse aggregate. It was free from impurities such as dust, clay particles and organic matter etc. The physical properties of coarse aggregate were investigated in accordance with **IS 2386 - 1963.** The specific gravity of coarse aggregate is 2.63, The Bulk density of coarse aggregate is 1.586 g/cc, the void ratio of coarse aggregate is 44.23 %, the water absorption of coarse aggregate is 1.2%, The Impact strength of coarse aggregate is 23.55% and the crushing strength of coarse aggregate is 16 %.

Table 2: *Physical properties of Coarse aggregate*

Description	**Test results**
Specific gravity	2.63
Water Absorption	2%
Unit weight(kg/m3)	1658
CrushingStrength	17.41%
Bulk density	1.586 g/cc
Flakiness	16.68%

CEMENT

Cement is a binding material used in the concrete for binding all the material together present in the concrete. Cement is tested as per IS recommendations. The cement that is used in the project is tested in the laboratory as per IS 4031. Ordinary Portland Cement of grade 53 is used for the research purpose. The test data for the cement is listed in the table below.

Table 3: *Properties of cement*

S.No	**Description**	**Values**
1	Specific gravity	3.14
2	Finess	1g
3	Soundness	1mm
4	Setting time	
	(i) Initial	32 min
	(ii) Final	486 min
5	Standard Consistency	30%

MARBLE DUST

The study of marble waste could be used as cementations material in concrete mixtures where they are in dust form, could be used as cementations material in concrete mixtures where they are available and the cost of construction is lower than ordinary concrete materials.

Table 4: *Physical properties of Marble test*

Description	Test results obtained
Specific gravity	2.66
Finess	12%
Unit weight (kg/m3)	1570 kg/m^3

RICE HUSK ASH

Rice husk ash is the by-product of burning rice husk. Rice husk is extremely prevalent in milling of paddy which comes from the fields. This rice husk is mostly used as fuel in the Boilers for processing of paddy. It has 54% calcium content.

Table 5: *Physical properties of rice husk ash*

Description	Test results
Specific gravity	2.3
Bulk density	0.3272
Unit weight (kg/m3)	1.68

SISAL FIBER

Sisal fibre is a natural fibre with the botanical name Agave sisalana native to southern Mexico. It is traditionally used for rope and twine, and has many other uses, including paper, cloth, footwear, hats, bags, carpets and dartboards. This fibre is used in the concrete to increase the tensile strength of concrete. It mainly resist the minor cracks and also to improve its durability. The properties of the sisal fibre is listed in the table below.

Table 6: *Properties of sisal fibre*

S.No	Description	Values
1	Cellulose	55-65%
2	Lignin	10-20%
3	Water soluble materials	1-4%
4	Aspect Ratio	100
5	Tenacity	0.22
6	Thickness	0.1mm
7	Length	10mm

RESULTS AND DISCUSSION

Destructive Strength

The Destructive strength of concrete is conducted by various methods in laboratory as well as in site places. This test were carried out in accordance with **IS 516-1999**. The standard size of specimens 150x150x150mm were casted and specimens were cured for a period of 7 days, 14 Days & 28 Days and then the specimens were taken out dried and tested in Compression Testing Machine. The strength is calculated in N/mm^2.

The compressive strength calculate by using formula

Fc = P/A

F c = Compressive strength N/mm^2

P = Ultimate load kN

A = Loaded area mm^2

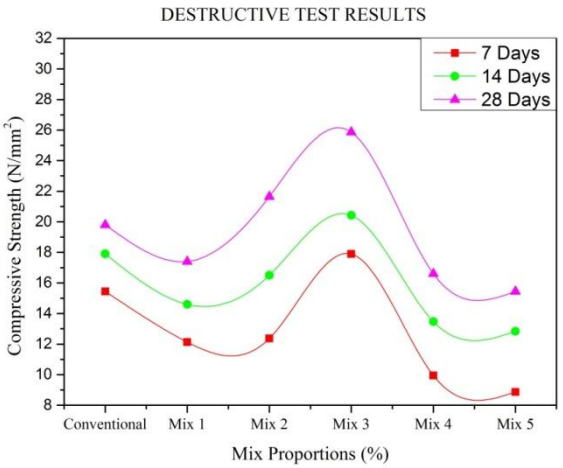

Fig.1: *Compressive Strength by NDT*

Results of cube specimen after curing period of 7 days, 14 days and 28 days. A maximum value of 26.45 N/mm^2 is obtained in mix 3. Mix 1 comprises of 0% marble dust and 30% Rha. In the upcoming mixes marble dust is increased by 5% continuously and the remaining is filled with RHA in a total of 30% replacement for cement.

Non Destructive Strength

The Non Destructive strength test is generally carried out by using rebound Hammer Test. This test were carried out in accordance with **IS 13311 (2) -1992**. The standard size of specimens 150x150x150mm were casted and specimens were cured for a period of 7 days, 14 Days & 28 Days. Then the test specimens were taken out and it is dried and then the rebound hammer is placed 90º to the surface of the specimen. The surface is smoothened before testing. Now the reading from the rebound hammer and the graph present were used to calculate the compressive strength of concrete without destructing it.

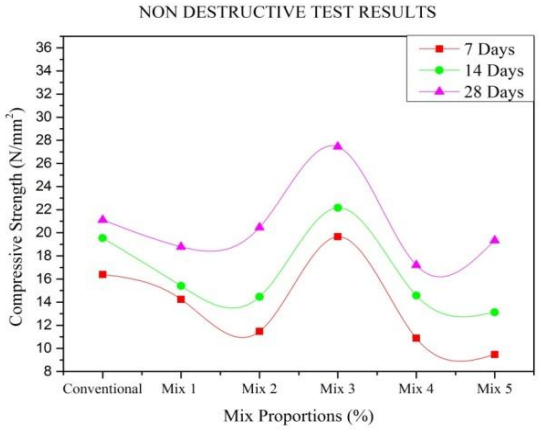

Fig.2: *Compressive Strength*

This figure shows the compressive strength of various mix proportions tested after the curing periods of 7 days, 14 days, 28 days tested by non destructive method. Normally Rebound hammer is used for finding the *compressive strength results.*

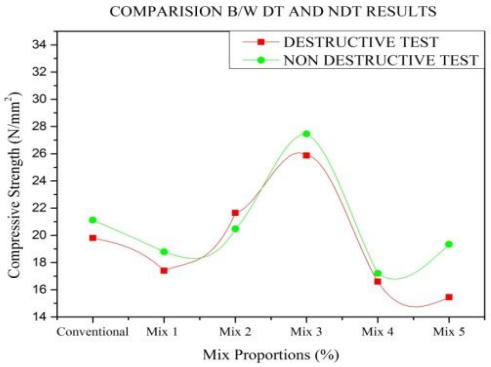

Fig.3: *Comparison results*

This figure shows the comparison between the test results of compressive strength of concrete tested by destructive and non destructive method after a curing period of 28 days. The result obtained from the non destructive test is slightly varied from the destructive test results. This figure shows that a maximum value is obtained in Mix 3.

CONCLUSION

The following conclusions are drawn within the limitation of the experimental investigation.

- Marble dust and rice husk ash can be used as a replacement for cement in order to reduce the cement content in the concrete.
- Up to 30% of cement replacement by these two mineral admixtures are possible.
- Along with the mineral admixtures, sisal fibber is used as a reinforcing element with aspect ratio of 100.
- Sisal fibre with 0.1mm diameter is cut down to a length of 10mm to achieve a high tensile and flexural property.
- In these mixes with 0.1% sisal fibber added along the mineral admixture concrete, mix 3 attains the maximum compressive strength.
- A maximum value of 26.45 N/Sq.mm is obtained from the compression testing machine.
- The highest value is obtained from mix 3 which comprises of 15% marble dust and 15% rice husk ash in a total replacement of 30% of cement.
- As marble dust contains high silica and RHA being a pozzolonic material the property of the concrete is good. Sisal fibre is added as a reinforcing agent to improve the tensile strength and to red w3uce the minor cracks.

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